RI 7790

Bureau of Mines Report of Investigations/ 1973

Methane Control by Isolation of a Major Coal Panel–Pittsburgh Coalbed

UNITED STATES DEPARTMENT OF THE INTERIOR

Report of Investigations 7790

Methane Control by Isolation of a Major Coal Panel—Pittsburgh Coalbed

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UNITED STATES DEPARTMENT OF THE INTERIOR
Rogers C. B. Morton, Secretary

BUREAU OF MINES
John D. Morgan, Jr., Acting Director

The work upon which this report is based was done under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Eastern Associated Coal Corp.

This publication has been cataloged as follows:

Findlay, Charles

Methane control by isolation of a major coal panel--Pittsburgh coalbed, by Charles Findlay, Stephen Krickovic, and J. E. Carpetta. [Washington] U.S. Bureau of Mines [1973]

11 p., illus., tables. (U.S. Bureau of Mines. Report of investigations 7790)

Based on work done in cooperation with Eastern Associated Coal Corp.

1. Methane. 2. Mine gases. 3. Mine ventilation. I. Krickovic, Stephen, jt. auth. II. Carpetta, John E., jt. auth. III. U.S. Bureau of Mines. IV. Title. (Series)

TN23.U7 no. 7790 622.06173

U.S. Dept. of the Int. Library

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METHANE CONTROL BY ISOLATION OF A MAJOR COAL PANEL–PITTSBURGH COALBED

by

Charles Findlay,[1] Stephen Krickovic,[2] and J. E. Carpetta[3]

ABSTRACT

As one of its projects for degasification of major panels of coal prior to mining within them, the Bureau of Mines conducted methane emission studies during development of a set of three headings 1,800 feet in a major coal panel (2,700 by 3,500 feet) which had been completely isolated by sets of main headings for 12 months in the Federal No. 2 mine (Pittsburgh coalbed) in northern West Virginia. Similar emission studies were conducted in the development of two sets of main headings in virgin coal areas nearby. Comparing the two sets of data indicated that the isolated coal panel had been degasified by approximately 70 percent.

INTRODUCTION

Methane exists under pressure in micropores, joints, and fractures of gassy coalbeds. In many mines it is also present in adjacent strata at various distances above and below the coalbed. An in situ gas pressure as high as 275 psi has been measured in the Pittsburgh coalbed, and the permeability of the bed is relatively high.[4] Because of this high pressure and permeability, it is advantageous from the standpoints of safety and productivity to degasify the coalbed as completely as possible before mining it. One procedure for draining methane from virgin coalbeds is to isolate major coal panels by developing sets of headings around them and to allow bleed-off for at least 1 year prior to mining within the panels.

Some coal companies have achieved and are achieving almost complete isolation without actually planning the technique. The usual reasons for developing sets of headings in areas adjacent to those being mined, and thereby obtaining a helpful degree of isolation, are ventilation problems, difficult mining conditions, and the need for greater production. In the relatively few cases where total isolation is planned, mining within the isolated panel is

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[1]Mining engineer (now retired).
[2]Supervisory mining engineer.
[3]Mining engineering technician.
[4]Cervik, Joseph. An Investigation of the Behavior and Control of Methane Gas. Min. Cong. J., v. 53, July 1967, pp. 52-57.

started immediately upon completion of the isolation. Although this does improve safety and productivity to some degree, more time should be allowed for methane bleed-off.

In other cases of mining in very gassy coalbeds, sets of headings are developed for longwall panels ahead of need to obtain some benefit from isolation, but more importantly to facilitate drilling degasification holes in the coalbed on both sides of the established longwall block.

Isolation of coal panels as a means of degasifying very gassy coalbeds adequately in advance of mining within the panels is an essential part of the Bureau's comprehensive methane control program. The objective of this study was to determine the quantity of methane that had drained from the 2,700- by 3,500-foot panel of Pittsburgh coal that had been completely isolated for 12 months in Federal No. 2 mine, Eastern Associated Coal Corp., and to develop data that would lead to a well-defined technology suitable for transfer to the coal mining industry.

ACKNOWLEDGMENTS

The cooperation of Eastern Associated Coal Corp. in conducting the various studies at their Federal No. 2 mine is greatly appreciated.

DESCRIPTION OF THE STUDY AREAS

Methane emissions were monitored at eight areas in Federal No. 2 mine (fig. 1):

Area 1 was located in the development of four headings of the 2 South mains to complete the set of ten 2 South mains headings of the 2,700- by 3,500-foot panel which had been totally isolated approximately 12 months before mining was started within it. Area 2 was located in six of the projected set of ten 2 North mains headings. The six headings had been developed 1,700 feet in virgin coal north of 1 East mains and the isolated panel.

Areas 3, 4, 5, 6, and 8 were located in a set of three headings being developed in the isolated block to improve ventilation. Areas 1, 3, 4, and 5 were approximately 400 feet apart, and areas 5, 6, and 8 were 300 feet apart. Thus, the length of the set of three headings studies was 1,800 feet of the 2,700-foot length of the short side of the block.

Area 7 was located in seven of the projected ten 2 South mains headings. These headings had been developed a distance of 1,000 feet south of the isolated block.

Development of the four sides of the isolated coal panel had been completed on the following dates: North airways near the coal shaft bottom, January 1, 1969; 1 East mains and East airways, January 1, 1970; and 2 South mains, April 1, 1971. When mining was started within the panel, the first side had been developed for 3-1/4 years, and the other two sides on the east and west courses for 2-1/4 years.

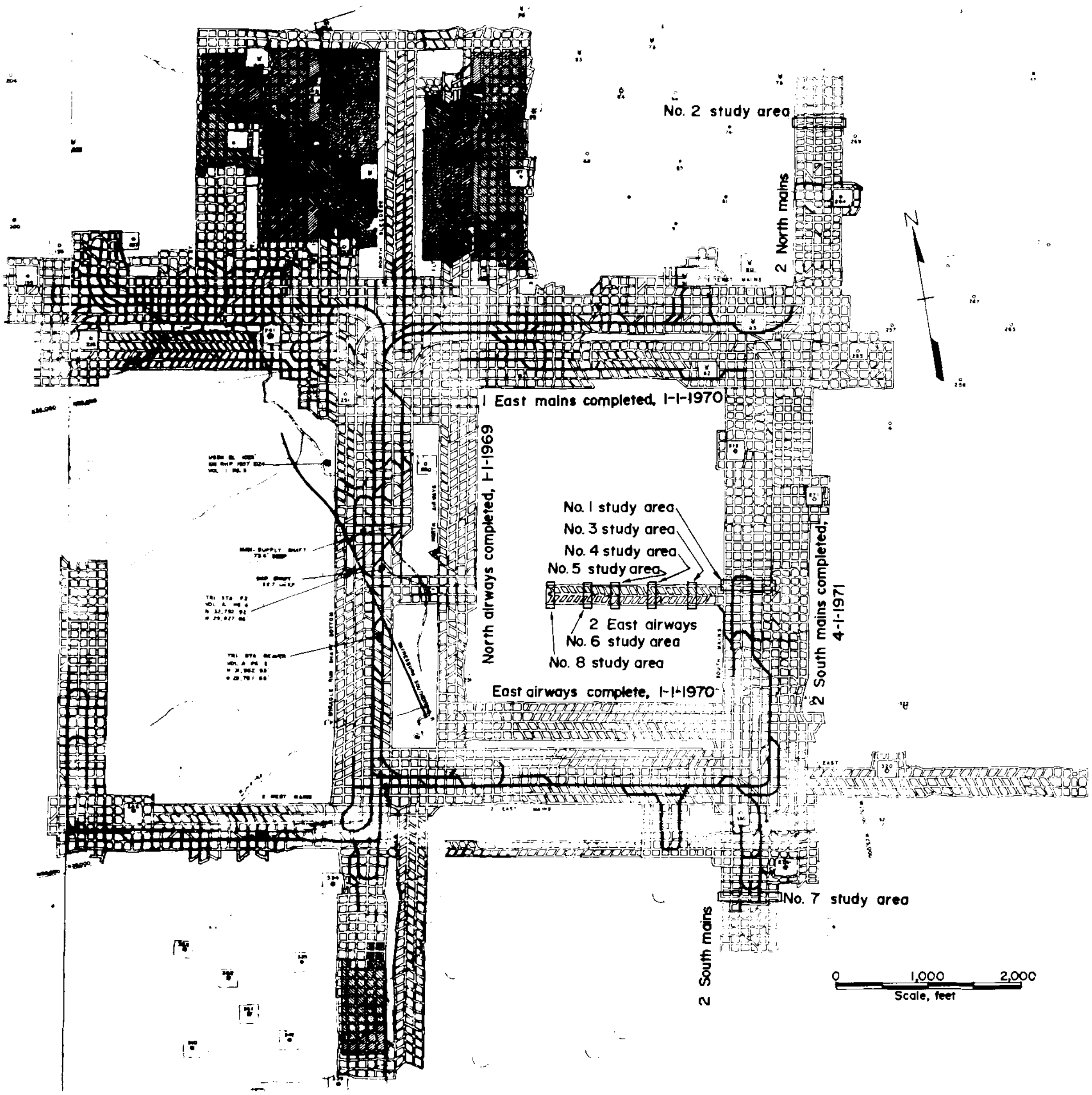

FIGURE 1. - Location of study areas.

MINING METHOD AND EQUIPMENT

The number of headings in a set, the centers and widths of headings and breakthroughs, and the angles of the breakthroughs with respect to the headings in the study areas are shown in table 1.

The coalbed was 9 feet thick, 7 feet of which was mined. The depth of the overburden ranged from 735 to 845 feet. Boring-type continuous miners were used in all study areas except area 7, where a full-face ripper-type unit was used. Mined coal was discharged from the booms of the miners to the floor, transferred by conventional loaders into 10-ton-capacity shuttle cars and from there to the tail ends of belt conveyors. Generally, two shuttle cars serviced each continuous miner. The roof was supported by steel bolts with expansion shells, installed with a hydraulic drill.

TABLE 1. - Data on mining layout in study areas

Study area[1]	Number of headings in a set	Heading centers, ft	Breakthrough centers, ft	Width of headings and breakthroughs, ft
1	4	90	90	13
2	6	90	80	13
3	3	100	80	13
4	3	100	80	13
5	3	100	80	13
6	3	100	80	13
7	7	100	90	14
8	3	100	80	13

[1] Study areas 1, 2, and 7 had breakthroughs at right angles to the heading, while study areas 3, 4, 5, 6, and 8 had breakthroughs angled 60 degrees on both sides of the middle heading.

VENTILATION

Three of the four headings in area 1 were used for intake air, with the air splitting in the inby line of open breakthroughs from the middle intake heading. The right split returned through the fourth heading toward the entrance to the section, and the left split through the existing adjacent heading of the set of six headings driven previously. The flow was in the opposite direction from that of the first air split. Total airflow was 38,000 cubic feet per minute (cfm), with 16,000 cfm in the left split and 22,000 cfm in the right split. The continuous miner was operated in both splits during the study.

In area 2, four headings were used for intake air, with the flow in the belt heading regulated to roughly 3,000 cfm. The total intake of 78,000 cfm was split left and right in the last inby line of open breakthroughs. Single headings on either side were used to return the air splits, with an average of 46,000 cfm in the right split and 32,000 cfm in the left. The continuous miner was operated in the lower volume split. The ventilation plan in area 7 was essentially the same as that in area 2, except that two headings were used for return air on the left side (airflow of 47,000 cfm) and one on the right side (airflow of 35,000 cfm), where the continuous miner was operated.

In areas 3, 4, 5, 6, and 8, the left heading was used for intake air and the right heading for return air. A belt conveyor was installed in the middle heading, where the intake air was regulated to roughly 3,000 cfm. The total intake airflow ranged from 29,000 cfm in study area 3 to 35,000 cfm in study area 8.

In all areas, auxiliary fans and reinforced tubing were used to ventilate the heading or breakthrough where the continuous miner worked. After completing mining in one place and tramming to another, line brattice was hung in the place just finished in the cycle. Exceptions occurred only when a breakthrough was completed between two adjacent headings, when arrangements were made to conduct the air through the breakthrough.

MONITORING

In preparation for the gas emission measurements, ventilation and haulage arrangements were observed in each study area and plotted on the area maps. Air and methane monitoring stations were then established.

In areas 1, 2, and 7, four men were employed as follows: A mining engineer to time study the operation of the continuous miner, note the number of shuttle cars loaded, and generally supervise the work; two mining engineering technicians to measure the cross-sectional areas of the established stations, to measure the return airflows by traversing uniformly the cross-sectional areas every hour with an anemometer and to measure with a hand-held methanometer the percent methane at the point of average velocity at 5 to 10 minute intervals; and one mining engineering technician to measure the intake airflows and percent methane in the same way as for the return airflows, and to note any changes in the ventilation arrangement during each shift.

To assure the use of the same procedures and thereby eliminate possible significant errors, monitoring was conducted by the same personnel in all studies. In study areas 3, 4, 5, 6, and 8 within the isolated panel, a mining engineer and two mining engineering technicians performed the work described above.

All instruments were checked and calibrated before each study and checked again after the study. Duplicate instruments were carried for checking during the studies to correct for unavoidable changes in calibration of any instrument.

RESULTS

The methane content in the intake air and in the immediate returns of operating and idle air splits of each study area are shown in figures 2 to 9. Pertinent data are summarized in table 2.

Isolated Panel

Particularly significant is the trend of methane emission as mining progressed in the isolated panel along a distance of 1,800 feet. Emission increased from 2.1 cubic feet per ton of coal mined in area 1 to 14 cubic feet in area 4 (800 feet from 2 South mains). At the end of the remaining 1,000 feet, emission dropped to 6 cubic feet per ton of coal mined. It is anticipated that the rate will be near zero just before cutting through to the North airways, where methane had been bleeding off for 3-1/2 years when monitoring was started.

TABLE 2. - Summary of pertinent data from methane emission studies in the isolated panel of coal and in two virgin areas

Date of study	Study area[1]	Average total air volume,[2] cfm	Average methane emission volume, cfm			Raw coal production, net tons	Continuous miner operating time, minutes	Average coal production, tons per minute	Average methane emission, cu ft per ton of coal mined	Remarks
			Intake	Return	Total					
2-23-72	1	38,000	75	6	81	330	113	2.92	2.1	Set of 4 headings.[3]
4-13-72	3	32,000	81	40	121	350	110	3.18	12.6	Set of 3 headings.[3]
5-16-72	4	34,000	80	52	132	350	94	3.73	14.0	Do.[3]
6-14-72	5	32,000	88	30	118	207	76	2.72	11.0	Do.[3]
7-20-72	6	35,000	87	17	104	203	104	1.95	8.7	Do.[3]
9-01-72	8	32,000	96	22	118	224	60	3.73	6.0	Do.[3]
3-22-72	2	[4]32,000	32	90	122	240	90	2.67	33.8	Set of 6 headings.[3]
8-07-72	7	[5]35,000	33	62	95	88	60	1.47	42.2	Set of 7 headings.[6]

[1]All study areas except 2 and 7 are in the isolated panel; study areas 2 and 7 are in virgin coal.
[2]All study areas in isolated panel were ventilated with one split air, except area 1 which had two splits in four headings.
[3]Boring-type continuous miner used. Cut cross-sectional area of 80 sq ft.
[4]Operating air split; two splits in section--total volume 79,000 cfm.
[5]Operating air split; two splits in section--total volume 82,000 cfm
[6]Ripper-type continuous miner used. Cut cross-sectional area of 100 sq ft.

NOTE.--Each area was studied during one operating shift. Air volumes in both active and idle air splits were combined in study area 1, to more closely correspond to the three headings on the active air split in all other study areas.

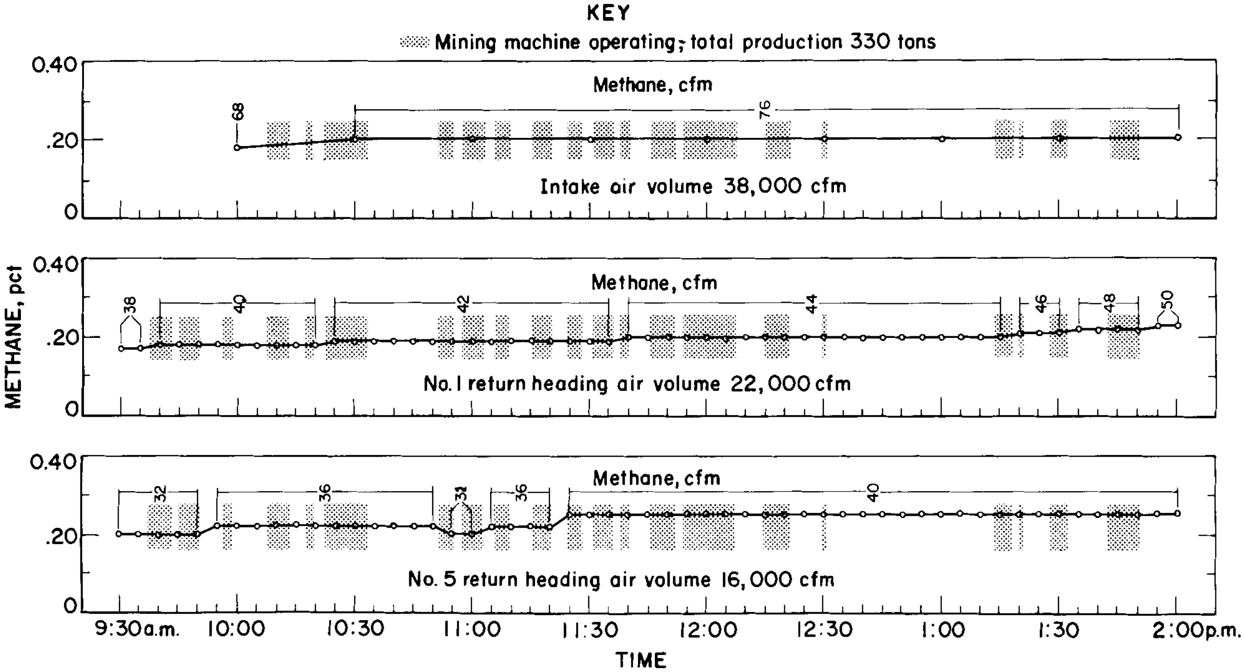

FIGURE 2. - Data from study area 1-isolated panel.

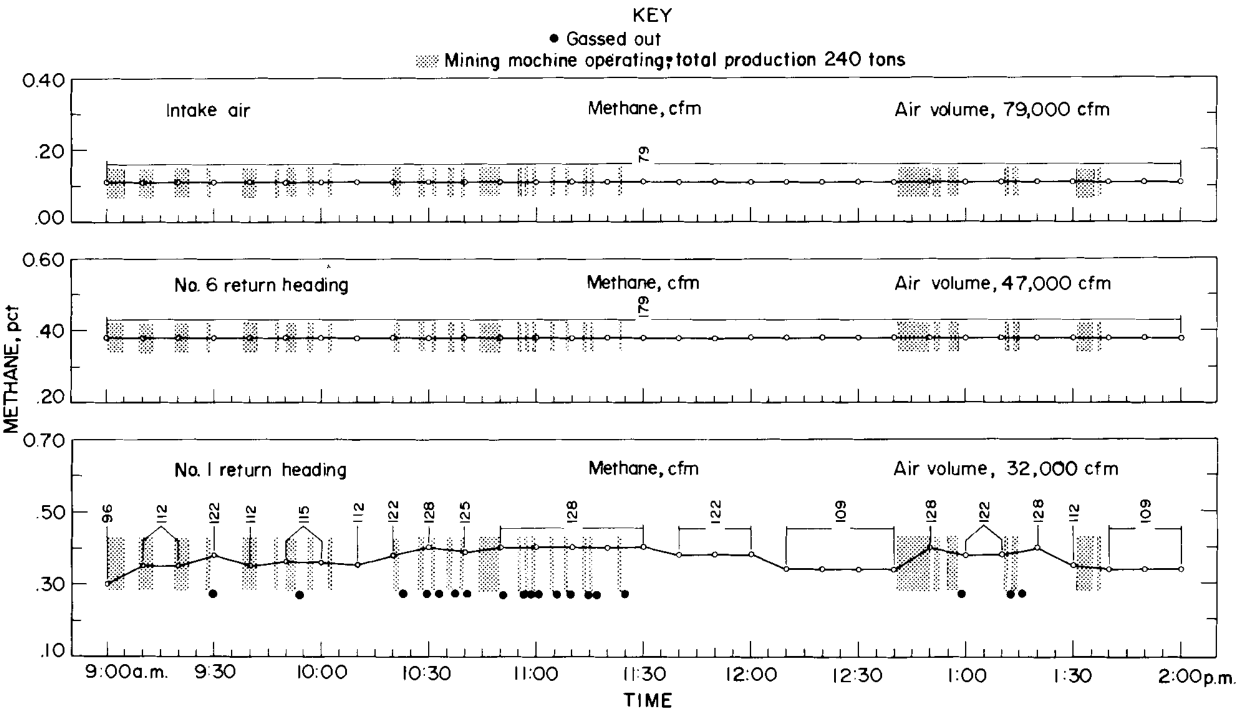

FIGURE 3. - Data from study area 2-2 North mains.

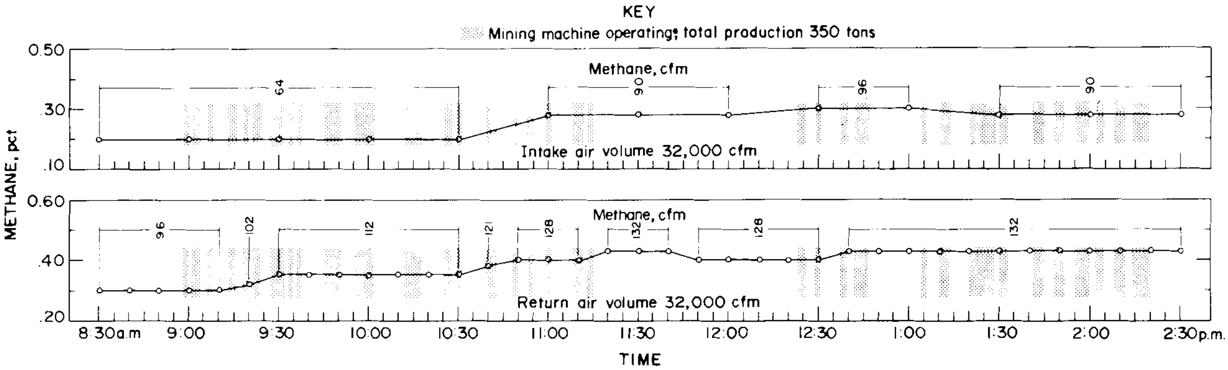

FIGURE 4. - Data from study area 3–isolated panel.

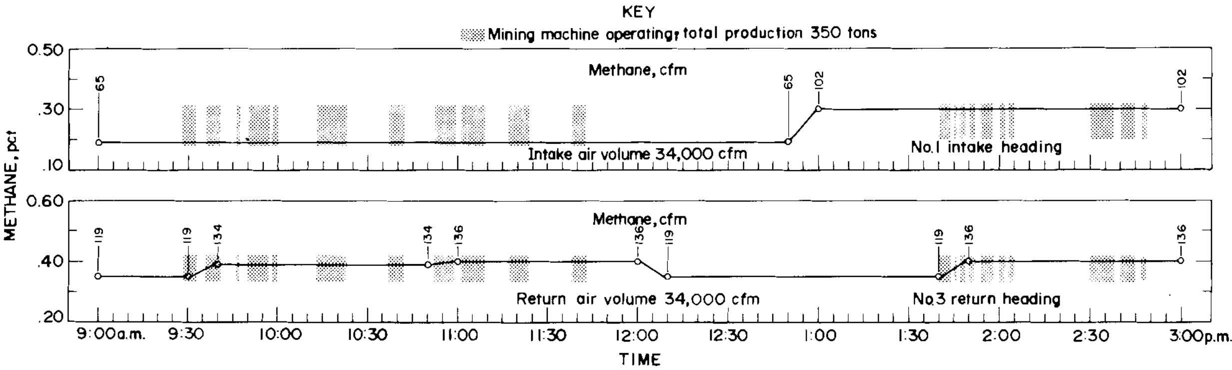

FIGURE 5. - Data from study area 4–isolated panel.

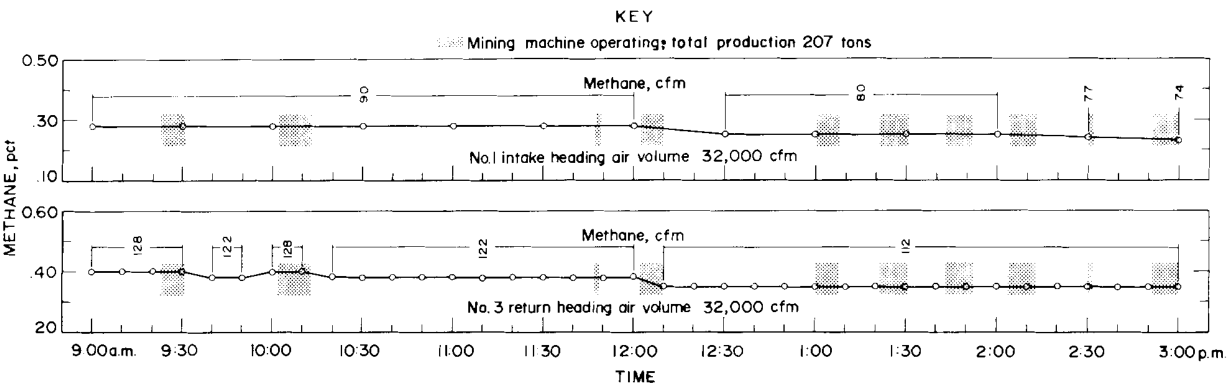

FIGURE 6. - Data from study area 5–isolated panel.

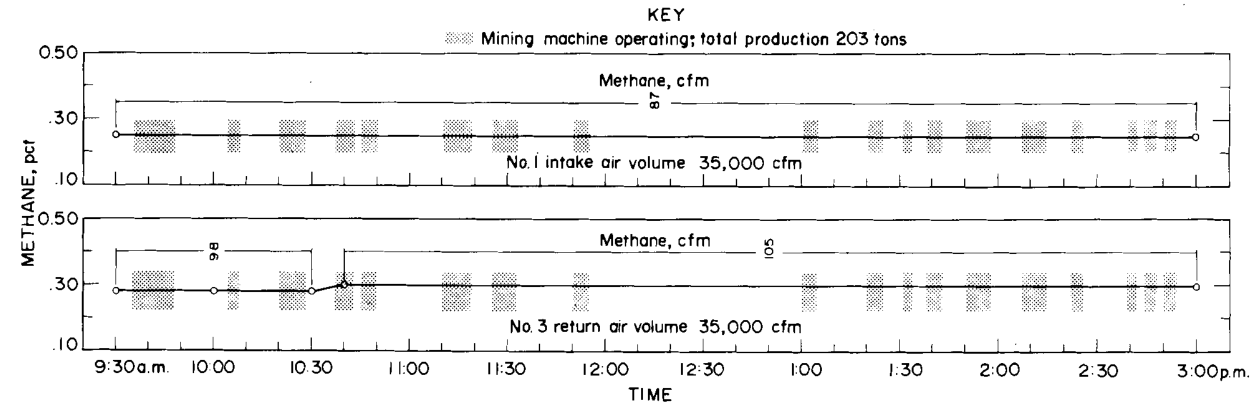

FIGURE 7. - Data from study area 6—isolated panel.

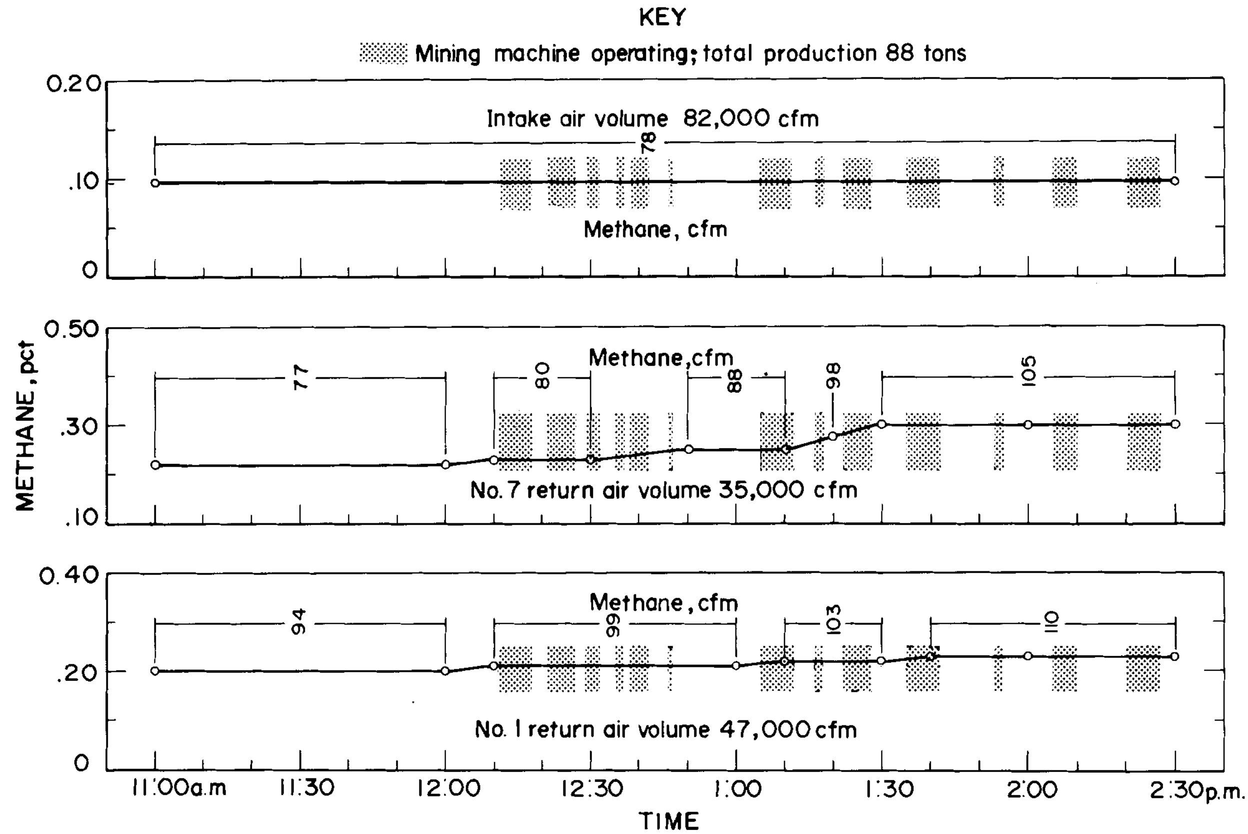

FIGURE 8. - Data from study area 7—2 South mains.

The highest and lowest average methane emission rates were observed in areas 4 and 1, respectively (table 2). In area 4 (fig. 5), the equivalent maximum methane concentration in the immediate return of the air split was 0.40 percent (136 cfm) during two different periods (11:00 to 12:00 a.m. and 1:50 to 3:00 a.m.) with the intake methane included, and 0.21 percent (71 cfm) in the first period and 0.10 percent (34 cfm) in the second period without the intake methane. In area 1 (fig. 2), the maximum concentration occurred during

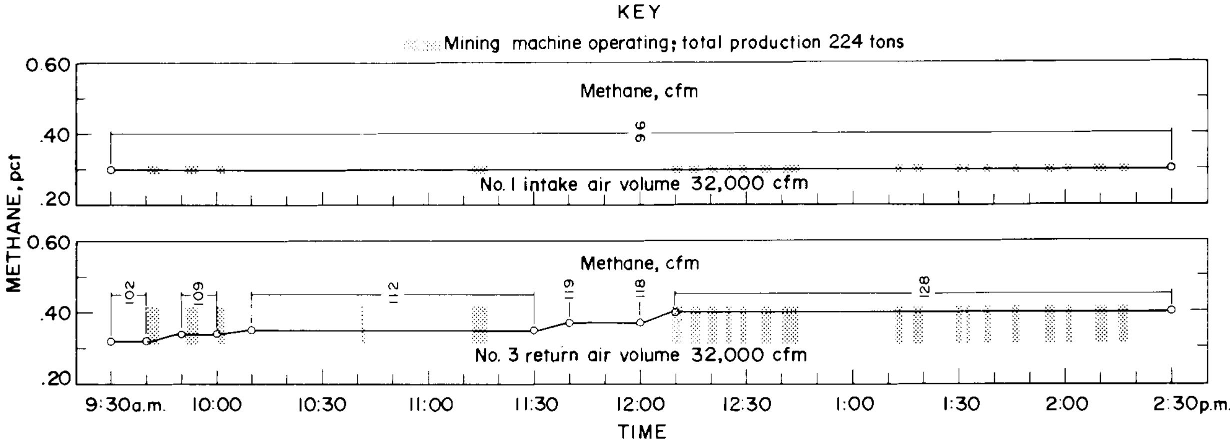

FIGURE 9. - Data from study area 8–isolated panel.

the last 30 minutes of the shift. The methane concentration was 0.24 percent (88 cfm) with the intake methane included, and 0.04 percent (12 cfm) without the intake methane.

In area 8 (fig. 9), 900 feet from the first developed set of headings of the isolated panel (North airways), the maximum methane concentration was 0.40 percent (128 cfm) during one period (12:10 to 2:30 p.m.) with the intake methane included and 0.10 percent (32 cfm) without the intake methane. As already mentioned, it is expected that the concentrations without methane from the intake air will drop to virtually zero when the North airways are intersected.

Virgin Coal Areas

Considering only the operating air split of 32,000 cfm in area 2 (fig. 3) within virgin coal, the highest average methane concentrations for 40 minutes in the immediate return airways with and without the intake methane were 0.40 and 0.30 percent, respectively. Despite this acceptable methane concentration, the methane detector mounted on the continuous miner approximately 10 feet ahead of the operator stopped the miner 19 times, for a total of 36 minutes, at 2.0-percent concentration.

In the operating air split of 35,000 cfm in area 7 (fig. 8) within virgin coal, the highest average methane concentrations for 60 minutes in the immediate return airways with and without the intake methane were 0.30 and 0.25 percent, respectively. There were no automatic stoppages of the miner by the methane detector such as occurred in area 2, because the long shuttle car haulage from the miner resulted in a slow rate of mining. During the period of highest methane emission in the operating air split in area 7 (105 cfm), the idle split contained even more methane (110 cfm). Two gas wells nearby undoubtedly contributed to the increased flow.

DISCUSSION

Mining within a major panel of coal which had been completely isolated for 12 months showed a significant and generally uniform reduction in methane emission rates as mining progressed within the panel (table 2). These methane reductions are represented both as cubic feet per minute, and as cubic feet per ton of coal mined. Comparing the average of 28 cfm (table 2) liberated in the six areas within the isolated panel with an average of 76 (90 and 62) cfm in the virgin areas 2 and 7 indicates that the methane content in the isolated panel had been reduced by 63 percent. Similar comparison of the average of 9.1 cubic feet per ton of coal mined in the isolated panel with the average of 38 (33.8 and 42.2) cubic feet in the two virgin areas showed a methane reduction of 76 percent. In either case, the weighted average production rate of 3.00 tpm in the isolated panel could have been doubled without exceeding the methane concentration in the immediate return airway.

It is noteworthy that the methane volume in the intake air conducted in all study areas averaged 85 cubic feet per minute (figs. 2-9 and table 2). This significant volume bled off from pillars and from mined coal while in transit to the shaft bottom from the various operating sections (very low from the isolated panel), and from transfer of all coal to the skips, which were hoisted in a shaft that served as an intake airway.

The frequent automatic stoppages of the continuous miner when mining in virgin coal (area 2), notwithstanding the acceptable methane concentration in the immediate return airway, show the need to develop methods for conducting a larger volume of air to the working face.

Although considerable degasification was obtained in the isolated panel made such by development of main headings for haulage and ventilation in a new mine, further studies are required to determine the safety and cost-effectiveness of mining butt headings in unisolated major panels, to develop a set of headings to isolate a major coal panel, and to develop four to five butt headings within the panel after 12 months of complete isolation. The objective is to obtain a body of pertinent data in predominantly mined, very gassy coalbeds that would permit any coal company to decide whether it would be practicable to undertake the isolation technique.

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